

191S143 GB  
SEQUENCE LISTING

<110> COMPAGNIE GERVAIS DANONE  
GENDRE, François  
BENBADIS, Laurent  
BRIGNON, Pierre

<120> MUTANT LACTOBACILLUS BULGARICUS STRAINS FREE  
FROM BETA-GALACTOSIDASE ACTIVITY

<130> MJPcb191/143

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<150> FR9806456

<151> 1998-05-22

<160> 3

<170> PatentIn Ver.. 2.1

<210> 1

<211> 5059

<212> DNA

<213> Lactobacillus bulgaricus

<220>

<221> CDS

<222> (122) .. (1873)

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<221> CDS

<222> (1877) .. (4519)

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g atg atc ttt atc atc acc aac ttg atc acc gcc atc cgg atc ggg gaa 169

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gtc ctg ctc gac ccc ttg atc ggt aac gcc atc gac cgg acc gaa agc 217  
 Val Leu Leu Asp<sub>20</sub> Pro Leu Ile Gly Asn<sub>25</sub> Ala Ile Asp Arg Thr<sub>30</sub> Glu Ser  
 cgg tgg ggg aag ttc aag ccc tgg gtt gtg ggc ggg ggg atc atc agc 265  
 Arg Trp Gly<sub>35</sub> Lys Phe Lys Pro Trp<sub>40</sub> Val Val Gly Gly Gly<sub>45</sub> Ile Ile Ser  
 tca tta gcc ctc tta gcc ctc ttt acc gac ttt ggc ggc att aac caa 313  
 Ser Leu<sub>50</sub> Ala Leu Leu Ala Leu<sub>55</sub> Phe Thr Asp Phe Gly<sub>60</sub> Gly Ile Asn Gln  
 agc aac ccc gtt gtt tac tta gta atc ttc ggt att gtt tac ttg att 361  
 Ser<sub>65</sub> Asn Pro Val Val Tyr<sub>70</sub> Leu Val Ile Phe Gly<sub>75</sub> Ile Val Tyr Leu Ile<sub>80</sub>  
 atg gat atc ttc tac tca ttt aaa gac act ggc ttc tgg gcc atg atc 409  
 Met Asp Ile Phe Tyr<sub>85</sub> Ser Phe Lys Asp Thr<sub>90</sub> Gly Phe Trp Ala Met<sub>95</sub> Ile  
 ccg gcc ttg tcc ctg gat tcc cgg gaa aga gag aag acc tcc acc ttc 457  
 Pro Ala Leu Ser<sub>100</sub> Leu Asp Ser Arg Glu<sub>105</sub> Arg Glu Lys Thr Ser Thr Phe  
 gcc aga gtc ggc tcc acc atc ggg gcc aac ctg gtc ggg gta gtc atc 505  
 Ala Arg Val<sub>115</sub> Gly Ser Thr Ile Gly<sub>120</sub> Ala Asn Leu Val Gly<sub>125</sub> Val Val Ile  
 acc cca atc atc ctc ttc ttc tcg gcc agc aag gcc aac ccc aac ggg 553  
 Thr Pro<sub>130</sub> Ile Ile Leu Phe Phe<sub>135</sub> Ser Ala Ser Lys Ala<sub>140</sub> Asn Pro Asn Gly  
 gat aag cag ggc tgg ttc ttc ttt gcc ttg atc gtg gcc att gtc ggc 601  
 Asp Lys Gln Gly Trp Phe<sub>150</sub> Phe Phe Ala Leu Ile<sub>155</sub> Val Ala Ile Val Gly<sub>160</sub>  
 atc ttg acc tca att acc gtt ggt ctt ggt act cac gaa gta aaa tcc 649  
 Ile Leu Thr Ser Ile Thr Val Gly Leu Gly Thr His Glu Val Lys Ser

165

170

175

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Ala	Leu	Arg	Glu 180	Ser	Asn	Glu	Lys	Thr 185	Thr	Leu	Lys	Gln	Val 190	Phe	Lys	
gtc	ctg	ggg	caa	aac	gac	cag	ctc	ctc	tgg	ctg	gcc	ttt	gcc	tac	tgg	745
Val	Leu	Gly 195	Gln	Asn	Asp	Gln	Leu 200	Leu	Trp	Leu	Ala	Phe 205	Ala	Tyr	Trp	
ttt	tac	ggc	ctg	ggt	atc	aac	acc	ctg	aac	gct	ctg	caa	ctt	tac	tac	793
Phe	Tyr 210	Gly	Leu	Gly	Ile	Asn 215	Thr	Leu	Asn	Ala	Leu 220	Gln	Leu	Tyr	Tyr	
ttc	tca	tac	atc	tta	ggc	gat	gcc	cgc	ggc	tac	agc	ctg	ctt	tac	acc	841
Phe 225	Ser	Tyr	Ile	Leu	Gly 230	Asp	Ala	Arg	Gly	Tyr 235	Ser	Leu	Leu	Tyr	Thr 240	
atc	aac	acc	ttt	gtc	ggt	tta	atc	tct	gca	tcc	ttc	ttc	cca	tca	ctg	889
Ile	Asn	Thr	Phe	Val 245	Gly	Leu	Ile	Ser	Ala 250	Ser	Phe	Phe	Pro	Ser 255	Leu	
gcc	aag	aag	ttc	aac	aga	aat	cgc	ctc	ttc	tac	gcc	tgc	atc	gcg	gtg	937
Ala	Lys	Lys	Phe 260	Asn	Arg	Asn	Arg	Leu 265	Phe	Tyr	Ala	Cys	Ile 270	Ala	Val	
atg	ctg	tta	ggg	atc	ggg	gtc	ttc	tcc	gtg	gcc	agc	ggt	tct	ctg	gcc	985
Met	Leu 275	Leu	Gly	Ile	Gly	Val	Phe 280	Ser	Val	Ala	Ser	Gly 285	Ser	Leu	Ala	
ctg	tcc	ctt	gtt	ggg	gca	gaa	ttc	ttc	ttt	att	ccg	cag	cct	ctg	gcc	1033
Leu	Ser 290	Leu	Val	Gly	Ala	Glu 295	Phe	Phe	Phe	Ile	Pro 300	Gln	Pro	Leu	Ala	
ttc	ctg	gtc	gtt	ttg	atg	atc	atc	tct	gac	gct	gtt	gaa	tac	ggc	cag	1081
Phe 305	Leu	Val	Val	Leu	Met 310	Ile	Ile	Ser	Asp	Ala 315	Val	Glu	Tyr	Gly	Gln 320	
ctg	aaa	act	ggc	cac	aga	gac	gaa	gct	ttg	acc	ctg	tct	gtc	cgg	cca	1129

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Leu	Val	Asp	Lys	Leu	Gly	Gly	Ala	Leu	Ser	Asn	Trp	Phe	Val	Ser	Leu	
			340					345					350			
att	gcc	tta	act	gcc	ggc	atg	acc	act	ggg	gcg	act	gcc	tca	aca	att	1225
Ile	Ala	Leu	Thr	Ala	Gly	Met	Thr	Thr	Gly	Ala	Thr	Ala	Ser	Thr	Ile	
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aca	gct	cat	ggc	cag	atg	gtc	ttc	aag	tta	gct	atg	ttt	gcc	tta	ccg	1273
Thr	Ala	His	Gly	Gln	Met	Val	Phe	Lys	Leu	Ala	Met	Phe	Ala	Leu	Pro	
	370					375					380					
gca	gtc	atg	ctc	ttg	atc	gct	gtt	tct	att	ttc	gcc	aaa	aag	gtc	ttc	1321
Ala	Val	Met	Leu	Leu	Ile	Ala	Val	Ser	Ile	Phe	Ala	Lys	Lys	Val	Phe	
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ttg	act	gaa	gaa	aag	cac	gcg	gaa	atc	gtc	gac	cag	ctg	gaa	act	caa	1369
Leu	Thr	Glu	Glu	Lys	His	Ala	Glu	Ile	Val	Asp	Gln	Leu	Glu	Thr	Gln	
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ttc	agc	caa	agc	cat	gcc	caa	aag	ccg	gcg	caa	gct	gaa	agc	ttc	act	1417
Phe	Ser	Gln	Ser	His	Ala	Gln	Lys	Pro	Ala	Gln	Ala	Glu	Ser	Phe	Thr	
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ttg	gcc	agc	cca	gtc	tcc	gga	caa	tta	atg	aac	ctg	gac	atg	gtt	gac	1465
Leu	Ala	Ser	Pro	Val	Ser	Gly	Gln	Leu	Met	Asn	Leu	Asp	Met	Val	Asp	
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gac	ccg	gtc	ttt	gcc	gac	aaa	aag	tta	ggc	gac	ggc	ttt	gcc	ctg	gtg	1513
Asp	Pro	Val	Phe	Ala	Asp	Lys	Lys	Leu	Gly	Asp	Gly	Phe	Ala	Leu	Val	
	450					455					460					
cca	gca	gac	ggt	aag	gtc	tac	gcg	cca	ttt	gcc	ggt	act	gtc	cgc	cag	1561
Pro	Ala	Asp	Gly	Lys	Val	Tyr	Ala	Pro	Phe	Ala	Gly	Thr	Val	Arg	Gln	
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ctg gcc aag acc cgg cac tcg atc gtc ctg gaa aat gaa cat ggg gtc	1609
Leu Ala Lys Thr Arg His Ser Ile Val Leu Glu Asn Glu His Gly Val	
485 490 495	
ttg gtc ttg att cac ctt ggc ctg ggc acg gtc aaa tta aac ggg act	1657
Leu Val Leu Ile His Leu Gly Leu Gly Thr Val Lys Leu Asn Gly Thr	
500 505 510	
ggc ttt gtc agc tat gtt gaa gag ggc agc cag gta gaa gcc ggc cag	1705
Gly Phe Val Ser Tyr Val Glu Glu Gly Ser Gln Val Glu Ala Gly Gln	
515 520 525	
cag atc ctg gaa ttc tgg gac ccg gcg atc aag cag gcc aag ctg gac	1753
Gln Ile Leu Glu Phe Trp Asp Pro Ala Ile Lys Gln Ala Lys Leu Asp	
530 535 540	
gac acg gta atc gtg acc gtc atc aac agc gaa act ttc gca aat agc	1801
Asp Thr Val Ile Val Thr Val Ile Asn Ser Glu Thr Phe Ala Asn Ser	
545 550 555 560	
cag atg ctc ttg ccg atc ggc cac agc gtc caa gcc ctg gat gat gta	1849
Gln Met Leu Leu Pro Ile Gly His Ser Val Gln Ala Leu Asp Asp Val	
565 570 575	
ttc aag tta gaa ggg aag aat tag aaa atg agc aat aag tta gta aaa	1897
Phe Lys Leu Glu Gly Lys Asn Met Ser Asn Lys Leu Val Lys	
580 585 590	
gaa aaa aga gtt gac cag gca gac ttg gcc tgg ctg act gac ccg gaa	1945
Glu Lys Arg Val Asp Gln Ala Asp Leu Ala Trp Leu Thr Asp Pro Glu	
595 600 605	
gtt tac gaa gtc aat aca att ccc ccg cac tcc gac cat gag tcc ttc	1993
Val Tyr Glu Val Asn Thr Ile Pro Pro His Ser Asp His Glu Ser Phe	
610 615 620	
caa agc cag gaa gaa ctg gag gag ggc aag tcc agt tta gtg cag tcc	2041

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Gln	Ser	Gln	Glu	Glu	Leu	Glu	Glu	Gly	Lys	Ser	Ser	Leu	Val	Gln	Ser	
625						630					635					
ctg	gac	ggg	gac	tgg	ctg	att	gac	tac	gct	gaa	aac	ggc	cag	gga	cca	2089
Leu	Asp	Gly	Asp	Trp	Leu	Ile	Asp	Tyr	Ala	Glu	Asn	Gly	Gln	Gly	Pro	
640					645					650					655	
gtc	aac	ttc	tat	gca	gaa	gac	ttt	gac	gat	agc	aat	ttt	aag	tca	gtc	2137
Val	Asn	Phe	Tyr	Ala	Glu	Asp	Phe	Asp	Asp	Ser	Asn	Phe	Lys	Ser	Val	
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aaa	gta	ccc	ggc	aac	ctg	gaa	ctg	caa	ggc	ttt	ggc	cag	ccc	cag	tat	2185
Lys	Val	Pro	Gly	Asn	Leu	Glu	Leu	Gln	Gly	Phe	Gly	Gln	Pro	Gln	Tyr	
			675					680					685			
gtc	aac	gtc	caa	tat	cca	tgg	gac	ggc	agt	gag	gag	att	ttc	ccg	ccc	2233
Val	Asn	Val	Gln	Tyr	Pro	Trp	Asp	Gly	Ser	Glu	Glu	Ile	Phe	Pro	Pro	
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caa	att	cca	agc	aaa	aat	ccg	ctc	gct	tct	tat	gtc	aga	tac	ttt	gac	2281
Gln	Ile	Pro	Ser	Lys	Asn	Pro	Leu	Ala	Ser	Tyr	Val	Arg	Tyr	Phe	Asp	
	705					710					715					
ctg	gat	gaa	gct	ttc	tgg	gac	aag	gaa	gtc	agc	ttg	aag	ttt	gac	ggg	2329
Leu	Asp	Glu	Ala	Phe	Trp	Asp	Lys	Glu	Val	Ser	Leu	Lys	Phe	Asp	Gly	
720					725					730					735	
gcg	gca	aca	gcc	atc	tat	gtc	tgg	ctg	aac	ggc	cac	ttc	gtc	ggc	tac	2377
Ala	Ala	Thr	Ala	Ile	Tyr	Val	Trp	Leu	Asn	Gly	His	Phe	Val	Gly	Tyr	
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ggg	gaa	gac	tcc	ttt	acc	cca	agc	gag	ttt	atg	gtt	acc	aag	ttc	ctc	2425
Gly	Glu	Asp	Ser	Phe	Thr	Pro	Ser	Glu	Phe	Met	Val	Thr	Lys	Phe	Leu	
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aag	aaa	gaa	aat	aac	cgc	ctg	gca	gtg	gct	ctc	tac	aag	tat	tct	tcc	2473
Lys	Lys	Glu	Asn	Asn	Arg	Leu	Ala	Val	Ala	Leu	Tyr	Lys	Tyr	Ser	Ser	
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 Ala Ser Trp Leu Glu Asp Gln Asp Phe Trp Arg Met Ser Gly Leu Phe  
 785 790 795  
 aga tca gtg act ctt cag gcc aag ccg cgt ctg cac ttg gag gac ctt 2569  
 Arg Ser Val Thr Leu Gln Ala Lys Pro Arg Leu His Leu Glu Asp Leu  
 800 805 810 815  
 aag ctt acg gcc agc ttg acc gat aac tac caa aaa gga aag ctg gaa 2617  
 Lys Leu Thr Ala Ser Leu Thr Asp Asn Tyr Gln Lys Gly Lys Leu Glu  
 820 825 830  
 gtc gaa gcc aat att gcc tac cgc ttg cca aat gcc agc ttt aag ctg 2665  
 Val Glu Ala Asn Ile Ala Tyr Arg Leu Pro Asn Ala Ser Phe Lys Leu  
 835 840 845  
 gaa gtg cgg gat agt gaa ggt gac ttg gtt gct gaa aag ctg ggc cca 2713  
 Glu Val Arg Asp Ser Glu Gly Asp Leu Val Ala Glu Lys Leu Gly Pro  
 850 855 860  
 atc aga agc gag cag ctg gaa ttc act ctg gct gat ttg cca gta gct 2761  
 Ile Arg Ser Glu Gln Leu Glu Phe Thr Leu Ala Asp Leu Pro Val Ala  
 865 870 875  
 gcc tgg agc gcg gaa aag cct aac ctt tac cag gtc cgc ctg tat tta 2809  
 Ala Trp Ser Ala Glu Lys Pro Asn Leu Tyr Gln Val Arg Leu Tyr Leu  
 880 885 890 895  
 tac cag gca ggc agc ctc tta gag gtt agc cgg cag gaa gtg ggt ttc 2857  
 Tyr Gln Ala Gly Ser Leu Leu Glu Val Ser Arg Gln Glu Val Gly Phe  
 900 905 910  
 cgc aac ttt gaa cta aaa gac ggg att atg tac ctt aac ggc cag cgg 2905  
 Arg Asn Phe Glu Leu Lys Asp Gly Ile Met Tyr Leu Asn Gly Gln Arg  
 915 920 925  
 atc gtc ttc aag ggg gcc aac cgg cac gaa ttt gac agt aag ttg ggc 2953  
 Ile Val Phe Lys Gly Ala Asn Arg His Glu Phe Asp Ser Lys Leu Gly

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930

935

940

cgg gct atc aca gaa gag gat atg atc tgg gat atc aag acc atg aag 3001

Arg Ala Ile Thr Glu Glu Asp Met Ile Trp Asp Ile Lys Thr Met Lys  
945 950 955

cga agc aac atc aat gct gtc cgc tgc tct cac tac ccg aac cag tcc 3049

Arg Ser Asn Ile Asn Ala Val Arg Cys Ser His Tyr Pro Asn Gln Ser  
960 965 970 975

ctc ttt tac cgg ctc tgt gac aag tac ggc ctt tac gtc att gat gaa 3097

Leu Phe Tyr Arg Leu Cys Asp Lys Tyr Gly Leu Tyr Val Ile Asp Glu  
980 985 990

gct aac ctg gaa agc cac ggc acc tgg gaa aaa gtg ggg ggg cac gaa 3145

Ala Asn Leu Glu Ser His Gly Thr Trp Glu Lys Val Gly Gly His Glu  
995 1000 1005

gat cct agc ttc aat gtt cca ggc gat gac cag cat tgg ctg gga gcc 3193

Asp Pro Ser Phe Asn Val Pro Gly Asp Asp Gln His Trp Leu Gly Ala  
1010 1015 1020

agc tta tcc cgg gtg aag aac atg atg gct cgg gac aag aac cat gct 3241

Ser Leu Ser Arg Val Lys Asn Met Met Ala Arg Asp Lys Asn His Ala  
1025 1030 1035

tca atc ctg atc tgg tct tta ggc aat gag tct tac gcc ggc act gtc 3289

Ser Ile Leu Ile Trp Ser Leu Gly Asn Glu Ser Tyr Ala Gly Thr Val  
1040 1045 1050 1055

ttt gcc caa atg gct gat tac gtc cgg aag gct gat ccg acc cgg gtt 3337

Phe Ala Gln Met Ala Asp Tyr Val Arg Lys Ala Asp Pro Thr Arg Val  
1060 1065 1070

cag cac tat gaa ggg gtg acc cac aac cgg aag ttt gac gac gcc acc 3385

Gln His Tyr Glu Gly Val Thr His Asn Arg Lys Phe Asp Asp Ala Thr  
1075 1080 1085

cag att gaa agc cgg atg tat gct ccg gcc aag gta att gaa gaa tac 3433



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Gln Ile Glu Ser Arg Met Tyr Ala Pro Ala Lys Val Ile Glu Glu Tyr  
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 Leu Thr Asn Lys Pro Ala Lys Pro Phe Ile Ser Val Glu Tyr Ala His  
 1105 1110 1115  
 gcc atg ggc aac tcc gtc ggt gac ctg gcc gcc tac acg gcc ctg gaa 3529  
 Ala Met Gly Asn Ser Val Gly Asp Leu Ala Ala Tyr Thr Ala Leu Glu  
 1120 1125 1130 1135  
 aaa tac ccc cac tac cag ggc ggc ttc atc tgg gac tgg att gac caa 3577  
 Lys Tyr Pro His Tyr Gln Gly Gly Phe Ile Trp Asp Trp Ile Asp Gln  
 1140 1145 1150  
 gga ctg gaa aaa gac ggg cac ctg ctt tat ggg ggc gac ttc gat gac 3625  
 Gly Leu Glu Lys Asp Gly His Leu Leu Tyr Gly Gly Asp Phe Asp Asp  
 1155 1160 1165  
 cgg cca acc gac tat gaa ttc tgc ggg aac ggc ctg gtc ttt gct gac 3673  
 Arg Pro Thr Asp Tyr Glu Phe Cys Gly Asn Gly Leu Val Phe Ala Asp  
 1170 1175 1180  
 cgg act gaa tcg ccg aaa ctg gct aat gtc aag gcc ctt tac gcc aac 3721  
 Arg Thr Glu Ser Pro Lys Leu Ala Asn Val Lys Ala Leu Tyr Ala Asn  
 1185 1190 1195  
 ctt aag tta gaa gta aaa gat ggg cag ctc ttc ctc aaa aac gac aat 3769  
 Leu Lys Leu Glu Val Lys Asp Gly Gln Leu Phe Leu Lys Asn Asp Asn  
 1200 1205 1210 1215  
 tta ttt acc aac agc tca tct tac tac ttc ttg act agt ctt ttg gtc 3817  
 Leu Phe Thr Asn Ser Ser Ser Tyr Tyr Phe Leu Thr Ser Leu Leu Val  
 1220 1225 1230  
 gat ggc aag ttg acc tac cag agc cgg cct ctg acc ttt ggc ctg gag 3865  
 Asp Gly Lys Leu Thr Tyr Gln Ser Arg Pro Leu Thr Phe Gly Leu Glu  
 1235 1240 1245

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 Pro Gly Glu Ser Gly Thr Phe Ala Leu Pro Trp Pro Glu Val Ala Asp  
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 gaa aaa gga gag gtc gtc tac cgg gta acg gcc cac tta aaa gaa gac 3961  
 Glu Lys Gly Glu Val Val Tyr Arg Val Thr Ala His Leu Lys Glu Asp  
 1265 1270 1275  
 ttg cct tgg gcg gat gag ggc ttc act gtg gct gaa gca gaa gaa gta 4009  
 Leu Pro Trp Ala Asp Glu Gly Phe Thr Val Ala Glu Ala Glu Glu Val  
 1280 1285 1290 1295  
 gct caa aag ctg ccg gaa ttt aag ccg gaa ggg ccg cca gat tta gtt 4057  
 Ala Gln Lys Leu Pro Glu Phe Lys Pro Glu Gly Arg Pro Asp Leu Val  
 1300 1305 1310  
 gat tcc gac tac aac cta ggc ctg aaa gga aat aac ttc caa att ctc 4105  
 Asp Ser Asp Tyr Asn Leu Gly Leu Lys Gly Asn Asn Phe Gln Ile Leu  
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 ttc tcc aag gtc aag ggc tgg ccg gtt tcc ctc aag tat gcc ggt agg 4153  
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 1330 1335 1340  
 gaa tac ttg aag cgg ctg ccg gaa ttt acc ttc tgg ccg gcc ctg acg 4201  
 Glu Tyr Leu Lys Arg Leu Pro Glu Phe Thr Phe Trp Arg Ala Leu Thr  
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 gac aac gac cgg gga gct ggt tac ggc tat gat ctg gcc ccg tgg gaa 4249  
 Asp Asn Asp Arg Gly Ala Gly Tyr Gly Tyr Asp Leu Ala Arg Trp Glu  
 1360 1365 1370 1375  
 aat gcc ggc aag tat gcc cgc ttg aaa gac atc agc tgc gag gtc aag 4297  
 Asn Ala Gly Lys Tyr Ala Arg Leu Lys Asp Ile Ser Cys Glu Val Lys  
 1380 1385 1390  
 gaa gac tcc gtt ttg gtc aag act gcc ttt acg ttg cct gtc gcc tta 4345

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Glu Asp Ser Val Leu Val Lys Thr Ala Phe Thr Leu Pro Val Ala Leu  
 1395 1400 1405

aag ggt gat tta act gtg acc tat gaa gtc gat gga cgg ggc aag att 4393

Lys Gly Asp Leu Thr Val Thr Tyr Glu Val Asp Gly Arg Gly Lys Ile  
 1410 1415 1420

gct gta aca gct gac ttc cca ggc gcg gaa gaa gcc ggt ctc ttg cca 4441

Ala Val Thr Ala Asp Phe Pro Gly Ala Glu Glu Ala Gly Leu Leu Pro  
 1425 1430 1435

gcc ttt ggc ttg aac ctg gcc ctg cca aaa gaa ctg acc gat tac cgc 4489

Ala Phe Gly Leu Asn Leu Ala Leu Pro Lys Glu Leu Thr Asp Tyr Arg  
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500 tac tat ggt ctg gga cct aat gag agc taa ccagaccgct tggaaggtaa 4539

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 500 1460 1465

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500 ggaatttacg gccaatgggg cagacttgaa cttgtctgct ttgccatatt ctgccgccca 4719

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Arg	Trp	Gly	Lys	Phe	Lys	Pro	Trp	Val	Val	Gly	Gly	Gly	Ile	Ile	Ser
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Ser	Leu	Ala	Leu	Leu	Ala	Leu	Phe	Thr	Asp	Phe	Gly	Gly	Ile	Asn	Gln
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Ser	Asn	Pro	Val	Val	Tyr	Leu	Val	Ile	Phe	Gly	Ile	Val	Tyr	Leu	Ile
65					70					75					80
Met	Asp	Ile	Phe	Tyr	Ser	Phe	Lys	Asp	Thr	Gly	Phe	Trp	Ala	Met	Ile
				85					90					95	
Pro	Ala	Leu	Ser	Leu	Asp	Ser	Arg	Glu	Arg	Glu	Lys	Thr	Ser	Thr	Phe
			100					105					110		
Ala	Arg	Val	Gly	Ser	Thr	Ile	Gly	Ala	Asn	Leu	Val	Gly	Val	Val	Ile
		115					120					125			
Thr	Pro	Ile	Ile	Leu	Phe	Phe	Ser	Ala	Ser	Lys	Ala	Asn	Pro	Asn	Gly
	130					135					140				
Asp	Lys	Gln	Gly	Trp	Phe	Phe	Phe	Ala	Leu	Ile	Val	Ala	Ile	Val	Gly
145					150					155					160
Ile	Leu	Thr	Ser	Ile	Thr	Val	Gly	Leu	Gly	Thr	His	Glu	Val	Lys	Ser
				165					170					175	
Ala	Leu	Arg	Glu	Ser	Asn	Glu	Lys	Thr	Thr	Leu	Lys	Gln	Val	Phe	Lys
			180					185					190		
Val	Leu	Gly	Gln	Asn	Asp	Gln	Leu	Leu	Trp	Leu	Ala	Phe	Ala	Tyr	Trp
		195					200					205			

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Phe	Tyr	Gly	Leu	Gly	Ile	Asn	Thr	Leu	Asn	Ala	Leu	Gln	Leu	Tyr	Tyr
210						215					220				
Phe	Ser	Tyr	Ile	Leu	Gly	Asp	Ala	Arg	Gly	Tyr	Ser	Leu	Leu	Tyr	Thr
225					230					235					240
Ile	Asn	Thr	Phe	Val	Gly	Leu	Ile	Ser	Ala	Ser	Phe	Phe	Pro	Ser	Leu
				245					250					255	
Ala	Lys	Lys	Phe	Asn	Arg	Asn	Arg	Leu	Phe	Tyr	Ala	Cys	Ile	Ala	Val
			260					265					270		
Met	Leu	Leu	Gly	Ile	Gly	Val	Phe	Ser	Val	Ala	Ser	Gly	Ser	Leu	Ala
		275					280					285			
Leu	Ser	Leu	Val	Gly	Ala	Glu	Phe	Phe	Phe	Ile	Pro	Gln	Pro	Leu	Ala
	290					295					300				
Phe	Leu	Val	Val	Leu	Met	Ile	Ile	Ser	Asp	Ala	Val	Glu	Tyr	Gly	Gln
305					310					315					320
Leu	Lys	Thr	Gly	His	Arg	Asp	Glu	Ala	Leu	Thr	Leu	Ser	Val	Arg	Pro
				325					330					335	
Leu	Val	Asp	Lys	Leu	Gly	Gly	Ala	Leu	Ser	Asn	Trp	Phe	Val	Ser	Leu
			340					345					350		
Ile	Ala	Leu	Thr	Ala	Gly	Met	Thr	Thr	Gly	Ala	Thr	Ala	Ser	Thr	Ile
		355					360					365			
Thr	Ala	His	Gly	Gln	Met	Val	Phe	Lys	Leu	Ala	Met	Phe	Ala	Leu	Pro
	370					375					380				
Ala	Val	Met	Leu	Leu	Ile	Ala	Val	Ser	Ile	Phe	Ala	Lys	Lys	Val	Phe
385					390					395					400
Leu	Thr	Glu	Glu	Lys	His	Ala	Glu	Ile	Val	Asp	Gln	Leu	Glu	Thr	Gln
				405					410					415	
Phe	Ser	Gln	Ser	His	Ala	Gln	Lys	Pro	Ala	Gln	Ala	Glu	Ser	Phe	Thr
			420					425					430		
Leu	Ala	Ser	Pro	Val	Ser	Gly	Gln	Leu	Met	Asn	Leu	Asp	Met	Val	Asp
		435					440					445			
Asp	Pro	Val	Phe	Ala	Asp	Lys	Lys	Leu	Gly	Asp	Gly	Phe	Ala	Leu	Val
	450					455					460				

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Pro Ala Asp Gly Lys Val Tyr Ala Pro Phe Ala Gly Thr Val Arg Gln  
465 470 475 480

Leu Ala Lys Thr Arg His Ser Ile Val Leu Glu Asn Glu His Gly Val  
485 490 495

Leu Val Leu Ile His Leu Gly Leu Gly Thr Val Lys Leu Asn Gly Thr  
500 505 510

Gly Phe Val Ser Tyr Val Glu Glu Gly Ser Gln Val Glu Ala Gly Gln  
515 520 525

Gln Ile Leu Glu Phe Trp Asp Pro Ala Ile Lys Gln Ala Lys Leu Asp  
530 535 540

Asp Thr Val Ile Val Thr Val Ile Asn Ser Glu Thr Phe Ala Asn Ser  
545 550 555 560

Gln Met Leu Leu Pro Ile Gly His Ser Val Gln Ala Leu Asp Asp Val  
565 570 575

Phe Lys Leu Glu Gly Lys Asn  
580

<210> 3

<211> 880

<212> PRT

<213> Lactobacillus bulgaricus

<400> 3

Met Ser Asn Lys Leu Val Lys Glu Lys Arg Val Asp Gln Ala Asp Leu  
1 5 10 15

Ala Trp Leu Thr Asp Pro Glu Val Tyr Glu Val Asn Thr Ile Pro Pro  
20 25 30

His Ser Asp His Glu Ser Phe Gln Ser Gln Glu Glu Leu Glu Glu Gly  
35 40 45

Lys Ser Ser Leu Val Gln Ser Leu Asp Gly Asp Trp Leu Ile Asp Tyr  
50 55 60

Ala Glu Asn Gly Gln Gly Pro Val Asn Phe Tyr Ala Glu Asp Phe Asp  
65 70 75 80

Asp Ser Asn Phe Lys Ser Val Lys Val Pro Gly Asn Leu Glu Leu Gln  
85 90 95

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Gly	Phe	Gly	Gln	Pro	Gln	Tyr	Val	Asn	Val	Gln	Tyr	Pro	Trp	Asp	Gly
			100					105					110		
Ser	Glu	Glu	Ile	Phe	Pro	Pro	Gln	Ile	Pro	Ser	Lys	Asn	Pro	Leu	Ala
		115					120					125			
Ser	Tyr	Val	Arg	Tyr	Phe	Asp	Leu	Asp	Glu	Ala	Phe	Trp	Asp	Lys	Glu
	130					135					140				
Val	Ser	Leu	Lys	Phe	Asp	Gly	Ala	Ala	Thr	Ala	Ile	Tyr	Val	Trp	Leu
145					150					155					160
Asn	Gly	His	Phe	Val	Gly	Tyr	Gly	Glu	Asp	Ser	Phe	Thr	Pro	Ser	Glu
				165					170					175	
Phe	Met	Val	Thr	Lys	Phe	Leu	Lys	Lys	Glu	Asn	Asn	Arg	Leu	Ala	Val
			180					185					190		
Ala	Leu	Tyr	Lys	Tyr	Ser	Ser	Ala	Ser	Trp	Leu	Glu	Asp	Gln	Asp	Phe
		195					200					205			
Trp	Arg	Met	Ser	Gly	Leu	Phe	Arg	Ser	Val	Thr	Leu	Gln	Ala	Lys	Pro
	210					215					220				
Arg	Leu	His	Leu	Glu	Asp	Leu	Lys	Leu	Thr	Ala	Ser	Leu	Thr	Asp	Asn
225					230					235					240
Tyr	Gln	Lys	Gly	Lys	Leu	Glu	Val	Glu	Ala	Asn	Ile	Ala	Tyr	Arg	Leu
				245					250					255	
Pro	Asn	Ala	Ser	Phe	Lys	Leu	Glu	Val	Arg	Asp	Ser	Glu	Gly	Asp	Leu
			260					265					270		
Val	Ala	Glu	Lys	Leu	Gly	Pro	Ile	Arg	Ser	Glu	Gln	Leu	Glu	Phe	Thr
		275					280					285			
Leu	Ala	Asp	Leu	Pro	Val	Ala	Ala	Trp	Ser	Ala	Glu	Lys	Pro	Asn	Leu
	290					295					300				
Tyr	Gln	Val	Arg	Leu	Tyr	Leu	Tyr	Gln	Ala	Gly	Ser	Leu	Leu	Glu	Val
305					310					315					320
Ser	Arg	Gln	Glu	Val	Gly	Phe	Arg	Asn	Phe	Glu	Leu	Lys	Asp	Gly	Ile
				325					330					335	
Met	Tyr	Leu	Asn	Gly	Gln	Arg	Ile	Val	Phe	Lys	Gly	Ala	Asn	Arg	His
			340					345					350		

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Glu	Phe	Asp 355	Ser	Lys	Leu	Gly	Arg 360	Ala	Ile	Thr	Glu	Glu 365	Asp	Met	Ile
Trp	Asp 370	Ile	Lys	Thr	Met	Lys 375	Arg	Ser	Asn	Ile	Asn 380	Ala	Val	Arg	Cys
Ser 385	His	Tyr	Pro	Asn	Gln 390	Ser	Leu	Phe	Tyr	Arg 395	Leu	Cys	Asp	Lys	Tyr 400
Gly	Leu	Tyr	Val	Ile 405	Asp	Glu	Ala	Asn	Leu 410	Glu	Ser	His	Gly	Thr 415	Trp
Glu	Lys	Val	Gly 420	Gly	His	Glu	Asp	Pro 425	Ser	Phe	Asn	Val	Pro 430	Gly	Asp
Asp	Gln	His 435	Trp	Leu	Gly	Ala	Ser 440	Leu	Ser	Arg	Val	Lys 445	Asn	Met	Met
Ala	Arg 450	Asp	Lys	Asn	His	Ala 455	Ser	Ile	Leu	Ile	Trp 460	Ser	Leu	Gly	Asn
Glu 465	Ser	Tyr	Ala	Gly	Thr 470	Val	Phe	Ala	Gln	Met 475	Ala	Asp	Tyr	Val	Arg 480
Lys	Ala	Asp	Pro	Thr 485	Arg	Val	Gln	His	Tyr 490	Glu	Gly	Val	Thr	His 495	Asn
Arg	Lys	Phe	Asp 500	Asp	Ala	Thr	Gln	Ile 505	Glu	Ser	Arg	Met	Tyr 510	Ala	Pro
Ala	Lys	Val 515	Ile	Glu	Glu	Tyr	Leu 520	Thr	Asn	Lys	Pro	Ala 525	Lys	Pro	Phe
Ile 530	Ser	Val	Glu	Tyr	Ala	His 535	Ala	Met	Gly	Asn	Ser 540	Val	Gly	Asp	Leu
Ala 545	Ala	Tyr	Thr	Ala	Leu 550	Glu	Lys	Tyr	Pro	His 555	Tyr	Gln	Gly	Gly	Phe 560
Ile	Trp	Asp	Trp	Ile 565	Asp	Gln	Gly	Leu	Glu 570	Lys	Asp	Gly	His	Leu 575	Leu
Tyr	Gly	Gly	Asp 580	Phe	Asp	Asp	Arg	Pro 585	Thr	Asp	Tyr	Glu	Phe 590	Cys	Gly
Asn	Gly	Leu 595	Val	Phe	Ala	Asp	Arg 600	Thr	Glu	Ser	Pro	Lys 605	Leu	Ala	Asn



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Val 610	Lys	Ala	Leu	Tyr	Ala	Asn 615	Leu	Lys	Leu	Glu	Val 620	Lys	Asp	Gly	Gln
Leu 625	Phe	Leu	Lys	Asn	Asp 630	Asn	Leu	Phe	Thr	Asn 635	Ser	Ser	Ser	Tyr	Tyr 640
Phe	Leu	Thr	Ser	Leu 645	Leu	Val	Asp	Gly	Lys 650	Leu	Thr	Tyr	Gln	Ser	Arg 655
Pro	Leu	Thr	Phe 660	Gly	Leu	Glu	Pro	Gly 665	Glu	Ser	Gly	Thr	Phe	Ala	Leu
Pro	Trp	Pro 675	Glu	Val	Ala	Asp	Glu 680	Lys	Gly	Glu	Val	Val 685	Tyr	Arg	Val
Thr 690	Ala	His	Leu	Lys	Glu	Asp 695	Leu	Pro	Trp	Ala	Asp 700	Glu	Gly	Phe	Thr
Val 705	Ala	Glu	Ala	Glu	Glu 710	Val	Ala	Gln	Lys	Leu 715	Pro	Glu	Phe	Lys	Pro 720
Glu	Gly	Arg	Pro	Asp 725	Leu	Val	Asp	Ser	Asp 730	Tyr	Asn	Leu	Gly	Leu	Lys 735
Gly	Asn	Asn	Phe 740	Gln	Ile	Leu	Phe	Ser 745	Lys	Val	Lys	Gly	Trp 750	Pro	Val
Ser	Leu	Lys 755	Tyr	Ala	Gly	Arg	Glu 760	Tyr	Leu	Lys	Arg	Leu 765	Pro	Glu	Phe
Thr 770	Phe	Trp	Arg	Ala	Leu	Thr 775	Asp	Asn	Asp	Arg	Gly 780	Ala	Gly	Tyr	Gly
Tyr 785	Asp	Leu	Ala	Arg	Trp 790	Glu	Asn	Ala	Gly	Lys 795	Tyr	Ala	Arg	Leu	Lys 800
Asp	Ile	Ser	Cys	Glu 805	Val	Lys	Glu	Asp	Ser 810	Val	Leu	Val	Lys	Thr	Ala 815
Phe	Thr	Leu	Pro 820	Val	Ala	Leu	Lys	Gly 825	Asp	Leu	Thr	Val	Thr 830	Tyr	Glu
Val	Asp	Gly 835	Arg	Gly	Lys	Ile	Ala 840	Val	Thr	Ala	Asp	Phe 845	Pro	Gly	Ala
Glu 850	Glu	Ala	Gly	Leu	Leu	Pro 855	Ala	Phe	Gly	Leu	Asn 860	Leu	Ala	Leu	Pro

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Lys	Glu	Leu	Thr	Asp	Tyr	Arg	Tyr	Tyr	Gly	Leu	Gly	Pro	Asn	Glu	Ser
865					870					875					880